REMARKS

Claims 6, 10 and 15 have been amended to correct the problems noted by the Examiner.

Claims 1-3, 5-12 and 14-16 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as their invention.

The Examiner has objected to the term "steep" saying that it is not defined in the Specification. The Examiner's attention is called to page 7, lines 1-16. On lines 1-3, it is stated "This gradient protects all but the immediately vaporizing material from the high temperature". One example is given as 200°C/mm. It is believed that the term "steep thermal gradient" would clearly mean to one skilled in the art that the material other than the immediately vaporizing material will not be subjected to high temperature. The disclosure fully supports this definition.

Claims 6 and 15 have been amended to correct the ambiguities noted by the Examiner. It is believed that these claims are clear and definite. The Examiner should note that without active cooling, the first region would absorb heat from the rest of the apparatus and its temperature would rise.

As amended, claim 10 now clearly indicates that the regions are of the apparatus and the components are of the organic material. It is believed that this claim is now clear and definite.

Claims 1-3 and 5-7 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Kim et al. (US Pub. No. 2004/0016400 A1) in view of Yang et al. (US Pub. No. 2005/0072361 A1).

Claims 1 and 10 are the only independent claims in this case. Claim 1 is representative and employs an evaporation apparatus wherein the solid organic material in a first region is actively cooled to be below the vaporization temperature. A second region of the vaporization apparatus is heated above the vaporization temperature of the solid organic material. The arrangement is such that a steep thermal gradient is established across the thickness of the organic material between the first and second regions. The solid organic material from the first region is then metered at a controlled rate so that a thin cross-section is heated to vaporize this material to form a film on the substrate surface.

Kim et al. (US2004/0016400) do not provide a cooled first region and a heated second region of the vaporization apparatus. Kim et al. in fact teach away from cooling a portion of the crucible as shown clearly in Figures 5 and 6 where all sides of the crucible are in contact with heating elements C, C1, C2...Cn so as to enable his source to vaporize material adjoining the surface of the bottom plate and thereby minimize the residual of the deposition material [0071] and [0091].

Kim et al. provide a top heated crucible device that is very similar to the geometry disclosed by Spahn in US 6237529. In Spahn's device, the gradient across the organic material is very gradual since no active cooling is provided. Measurements of the temperature profile of the organic material contained in the crucible of Spahn show a 40°C temperature variation through a 20 mm thickness of vaporizable material. This small thermal gradient, 2°C/ mm, has been shown in actual use to not adequately isolate many vaporizable materials from the deleterious effects of prolonged thermal exposure. The device disclosed by Kim et al. include no features that would provide better thermal protection of the vaporizable material than the device of Spahn. Kim et al. acknowledge that intensive care must be taken to prevent decomposition of the organic material and yet provides no remedy beyond the method disclosed by Spahn, a method that has been shown to be inadequate for many organic materials.

Kim et al. disclose a way for maintaining a constant distance between the top heating element and the surface of the vaporizable material. Maintaining a constant heating distance by moving the heater relative to the surface of the organic material does not constitute metering of the organic material from a first cooled region to a second heated region. No apparatus is disclosed that can effect metering and no thermal break is provided to separate a cooled first region from a heated second region. Instead, all of the organic material is exposed to elevated temperatures for an extended period of time as the top surface of the material is slowly vaporized and conducts heat to the underlying organic material. The entirety of the solid organic material remains stationary relative to the crucible.

In view of the foregoing, since Kim et al. do not meter as in elements d in claims1 and 10 and does not actively cool, as required by element b in both claims and does note disclose the steep thermal gradient in the context of

the present invention, it is believed that claims 1 and 10 define unobvious subject matter.

Claim 3 depends upon claim 1 but further includes an interrupting feature. The paragraphs cited by the examiner in Kim et al. [0068, 0071 and 0072] speak to being able to vaporize all of the material in the crucible, even the material adjacent the bottom surface of the crucible. This has nothing to do with being able to stop vaporization at will. The apparatus of Kim et al. simply stop vaporizing material when the supply has been exhausted. Yang et al. [0059] describe a shutter mechanism 44 positioned between the heat source 30 and the substrate 12 for preventing heat damage and unwanted deposition on the substrate. The shutter does not interrupt vaporization, it simply interrupts deposition. Organic material continues to be vaporized and wasted when the shutter is interposed between the crucible and the substrate, vapor simply deposits on the shutter instead of the substrate.

Claim 8 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Kim et al. (US Pub. No. 2004/0016400 A1) in view of Yang et al. (US Pub. No. 2005/0072361) and further in view of Grant et al. (US Pub. No. 2003/0116091 A1).

Yang et al. (US 2005/0072361) describe a thermal evaporation system including a heating crucible 26 for containing a coating material 28 and a heat source 30 disposed so as to heat a surface 32 of a coating material contained in the heating crucible. Yang et al. further describe the inclusion of thermal insulation 60 around the crucible to contain heat within the crucible. The insulation 60 promotes temperature uniformity within the crucible and works to the detriment of establishing a thermal gradient through the depth of the coating material. The entire crucible will attain an equilibrium temperature nearly the same as that of the heat source through thermal conduction and due to the presence of insulation 60 and the insulating properties of vacuum. Yang et al. understood that even regions of their heating crucible the most remote from the heat source will attain temperatures comparable to the temperature of the heat source. They did this by indicating that the piston and piston seal, at the bottom of the material charge, be made from refractory material that resist high temperatures, like the crucible itself [0062].

Yang et al. teach away from cooling the crucible as evidenced by the inclusion of an insulating layer 60 between the crucible and the cooled shields 46. Further, Yang et al. do not teach, and have made no provision to create a thermal break through the vaporizable material that could produce a steep thermal gradient. Assuming for the sake of argument only, that Kim et al. and Yang et al. could be combined, there is clearly no motivation or suggestion of the steep thermal gradient taught and demonstrated in the in the method of claims 1 and 10. Yang et al. describe the inclusion of actively cooled radiation shields 46 in proximity to the insulated crucible 26 to reduce radiant heat transmission from the crucible to other equipment. The cooling shields 46 have cooling lines 42 coupled to their outer surface and are disposed adjacent the sidewalls of the insulation 60 covering the crucible 26. The cooling shields 46 are not in contact with the crucible or even in intimate thermal contact with the thermal insulation 60 covering the crucible. Instead, they are in close proximity to the insulation 60 and serve principally to reduce the radiant transfer of energy to other parts of the machine. Yang et al.'s intention to use the cooling shields to reduce the temperature of the crucible is limited to using them after an evaporation process, not during an evaporation process. Their use to increase the cooling rate of the crucible is very simply due to the fact that the transfer of radiant energy depends on the fourth power of the absolute temperature difference between the emitting and absorbing surfaces. The cooled surface of cooling shields 46 will simply re-radiate less energy back to the crucible 26 than a hot surface and hence reduce the time required to cool the crucible at the end of an evaporation process. The process is under vacuum, and there is no convective cooling. Without intimate mechanical contact that is neither described or suggested, there is no effective conductive cooling – it is all radiation.

Grant (US 2003/0116091) discloses a cooling jacket 162 in thermal contact with a liquid conduit 116 on a first side of a thermal divide in the vaporization apparatus, isolated from a heated vaporization chamber on the second side of the divide. Liquid precursors are atomized as they leave the cooled liquid conduit 116 on the first side of the thermal divide and by this atomization, create a break in the thermal path through the liquid that allows the liquid to remain cool on the first side of the thermal divide while allowing rapid heating of the liquid droplets on the second side of the thermal divide.

Without introducing a thermal divide in both the vaporization apparatus and the vaporizable liquid, the apparatus of Grant would not function as described. Heat would simply flow from the heated region to the cooled region, resulting in inadequate heating in the vaporization region and excessive heating in the cooled region.

Similarly, there is no reasonable expectation of success in cooling the crucible of Kim et al. using the liquid cooling jacket of Grant or the cooling shields of et al. since 1) Kim et al. teach away from cooling the crucible and 2) neither Kim et al. nor Yang et al. teach the use of a thermal break in combination with active cooling of a first region of the vaporization apparatus and active heating of a second region of the apparatus to produce a steep thermal gradient through the vaporizable material.

The present invention avoids the use of a heating crucible to prevent significant and substantial degradation of the vaporizable material over time. The present invention is very different than the pervasive prior art that teaches the use of a heating crucible where the vaporizable material is maintained at an elevated temperature and vaporizes from its free surface in close proximity to a radiant heat source.

Claim 9 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Kim et al. (US Pub. No. 2004/0016400 A1) in view of Yang et al. (US Pub. No. 2005/0072361 A1) and further in view of Peng. (US Pat. No. 6,467,427).

Claim 9 depends upon claim 1 and should be allowed along with it. It is quite clear that Peng does not provide the metering of claim 1 since he uses gravity to dispense organic material. Further he doesn't have the steep gradient in the context of claim 1. Applicants fail to see how Peng can reasonably be combined with any of the cited references since his structure is so different from any of them or the vapor deposition apparatus needed to practice the method of clams 1 and 10.

Claims 10-12, 14, and 15 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Kim et al. (US Pub. No. 2004/0016400 A1) in view of Yang et al. (US Pub. No. 2005/0072361 A1) and further in view of Yamazaki et al. (US Pub. No. 2002.0132047 A1).

Kim et al. and Yang et al. have been discussed above. Yamazaki US (2002/0132047) discloses no functional description of their crucible

evaporation sources and provides no more that cryptic descriptions of prior art crucibles. In paragraph [0144] they postulate that although they repeatedly describe a deposition system utilizing one material in each of multiple successive crucibles, it is possible to co-deposit more than one material from a single crucible. They provide no evidence that they have any idea of how this may be physically possible or the nuances involved.

Indeed, if the co-deposited materials have the same or very nearly the same saturation vapor pressure, it is possible to co-deposit them from a single source with an expectation of maintaining a constant constituent composition ratio throughout the deposition process. If the materials to be co-deposited from a single source do not have the same saturation vapor pressures, then the composition of the deposited film will vary, often erratically, over time. The more volatile constituents will be over represented in the deposited film when vaporization commences from a fresh material charge and will be under represented when the material charge is nearly exhausted. At first, the more volatile particles are directly exposed the high temperatures and vaporize very rapidly. Over time, the vaporization of the volatile materials is diffusion rate limited as the vapors must percolate through a matrix of less volatile material particles. The greater the disparity between the vapor pressures of the constituents, the greater the variability in the deposited film composition.

This process is known as thermal fractionalization or distillation and has been widely used for centuries to purify heterogeneous materials by separating them according to their volatility, exactly the opposite of what is needed when there is co-deposition of materials from a single vaporization source.

Applicants fail to see how Yamazaki et al. can reasonably be combined with Kim et al. and Yang et al.. It is true that Yamazaki et al. has two different materials but he provides no disclosure or suggestion how to the control the composition of the deposited film in the case where the components have substantially different vapor pressure characteristics. Further, he provides no suggestion of the apparatus needed to provide the method of claim 10. Accordingly, claims 10-12, 14, and 15 are believed to define unobvious subject matter.

Claim 16 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Kim et al. (US Pub. No. 2004/0016400 A1) in view of Yang et

al. (US Pub. No. 2005/0072361 A1), in further view of Yamazaki et al. (US Pub. No. 2002.0132047 A1), and in further view of Grant et al. (US Pub. No. 2003/0116091 A1).

Claim 16 depends upon claim 10 and should be allowable for the reasons set forth above that were presented with respect to claim 10.

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,

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If the Examiner is unable to reach the Applicant(s) Attorney at the telephone number provided, the Examiner is requested to communicate with Eastman Kodak Company Patent Operations at (585) 477-4656.